TRANSLATION

g = 0: CURRENT PROBLEMS IN BIOASTRONAUTICS

By

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FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

WRIGHT-PATTERSON AIR FORCE BASE

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g = 0: CURRENT PROBLEMS IN BIOASTRONAUTICS

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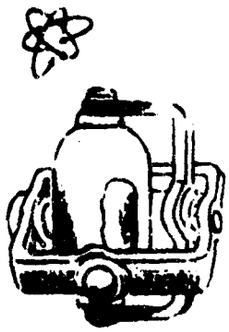
Bioastronautics – a recently coined term – expresses the correlations that have lately been established between the youngest of sciences, astronautics, and some of the oldest sciences: medicine and biology.

The moment it was realized that man has the possibility of penetrating into cosmic space, a series of problems arose. Among these was the one concerning whether the human organism will be able to withstand the conditions it encounters during flights in spaceships, as well as those it might have to face on other planets, i.e., outside the environment in which he came into being and to which he has adapted himself in the course of millions of years. What qualities will be required of the men who will undertake the first cosmic flights? How should the future astronaut be trained for these flights?

Answers to all these questions connected with



the possibility of life in an extraterrestrial environment have come and continue to come from space medicine and space biology.

The recent International Congress of Astronautics at Varna had a section devoted to bioastronautics, where scientists from U.S.S.R., U.S.A., Rumanian People's Republic, Sweden, etc., presented papers that were received with interest.

HAS THE PROBLEM OF WEIGHTLESSNESS BEEN SOLVED?

Among the problems raised by space flights, that of the influence of weightlessness on the human organism was very little known until a relatively short time ago.

Back at the 7th Congress of Astronautics, the results of 300 experiments on the effects of weightlessness of short duration had been presented. Half of the 16 persons who had participated in these experiments reported that weightlessness is pleasant, a quarter had unpleasant experiences: dizziness, nausea, lack of orientation, while the rest reported nothing unusual, having reacted with indifference. It was shown, as part of these experiments, that training increases tolerance to weightlessness.

At the recent Varna Congress, attention was again centered on these problems. They were discussed in a paper read to the scientists by the pilot-astronaut G.S. Titov, as well as in a report by the well-known Soviet physician, Professor V.I. Iazdovski. From what Titov had reported immediately after the flight, we learned that for a few hours, approximately after the sixth and the seventh orbits, the astronaut felt nausea and dizziness. The reactions are similar to sea- and air-sickness, and for this reason the term space sickness has made its appearance.

In his Varna report, Titov said that these symptoms were relieved when he adopted a strained posture and did not move his head. After sleeping, these sensations diminished considerably, and they disappeared completely during the entire period of overstress on reentry into the atmosphere. Working capacity was relatively little affected.

Soviet researchers believe that these reactions are caused by the quantitative and qualitative imbalance of nervous factors.

The fact that the American astronaut Glenn showed similar symptoms during his flight, which was very much shorter than Titov's, has raised questions among medical men and engineers.

The engineers have begun to talk about how it might be possible to create artificial weight under conditions of weightlessness.

However, as was reported by Titov and Iazdovski at the recent Congress, the preparations for the flight of the "space brothers" Nikolaev and Popovich included special training aimed at raising the organism's resistance to conditions brought about by weightlessness.

Thus, for the purpose of lowering the sensitivity of the vestibular apparatus* the astronauts were made to circle around three axes in rotary trainers while at the same time executing a series of commands. The astronaut was also made to stand up on a disk platform and was moved so as to have the same feeling he would experience on the deck of a ship tossed by the waves. The same goal was served by physical exercise in a swing rotating in the vertical plane and simultaneously around its longitudinal axis. In any event, we know that Nikolaev and Popovich did not suffer any kind of reactions. In addition, for the first time, following the doctor's instructions, they left their chairs and floated in the cabin for some time without ex-

Andrian Nikolaev training his vestibular apparatus in a swing.

periencing any unpleasant sensations.

It can be said that this very detailed and intensive training, ably guided by specialists, played an important part in the preparation of the Soviet astronauts for their flight.

The flight of the last two Soviet cosmonauts proved that, under the conditions of space flight with a duration of the order of 100 hours, a healthy man who is suitably prepared can withstand the state of weightlessness in an absolutely satisfactory manner.

On the basis of the first results of the group flight, it is possible to assume that suitably trained astronauts will be able to undertake flights of several hundred hours.

During the entire time of the flight, the general state and basic physiological functions of the astronauts remained within normal limits. As a consequence of the group flight, new scientific data was obtained, which is necessary to assure space flights of even longer duration.

The astronauts Nikolaev and Popovich experienced the free-floating state in the cabin for 3.5 and 3 hours, respectively; during this entire period they were in control of their capacity to orient themselves in the cabin, and maintained telecommunication. They felt well, experienced no unpleasant sensations, and had no functional disturbances.

WHY IS IT NECESSARY TO STERILIZE MOON AND INTERPLANETARY SHIPS?

The International Council of Scientific Unions has named a special committee, "Cetex," to deal with this problem.

We might recall that when the second cosmic rocket was launched (12 Sep 1959) to carry a flag to the moon, the Soviet specialists disinfected the whole craft in order to prevent the carrying of micro-organisms or traces of organic matter from Earth.

What is the reason for these important procedures?

It is obvious that through cosmic flights aimed at the moon or the nearest planets, it would be possible to carry to them material infected with many terrestrial germs, or bearing imperceptible traces of organic matter.

This would result in contamination of the new environment, which would in turn distort the results of biological research; germs carried from Earth to other planets, in case life might exist there, could constitute a great danger for extraterrestrial organisms that have no defense mechanisms against them. This could bring about phenomena of the epidemic type with disastrous consequences for the life of the celestial body involved.

Since it is so important to prevent the contamination of other planets, the problem of sterilizing lunar and interplanetary ships has become acute. Soviet scientists took the first measures in this direction 3 years ago. The sterilization of the container that landed on the moon was then a relatively simple matter, but the procedure becomes much more complicated in the case of ships carrying men who will probably leave the craft that carried them in order to explore the cosmic body on which they landed. This is a case that requires special precautions, since man is a system that, in principle, cannot be completely disinfected from a bacteriological viewpoint, because there are germs which are absolutely necessary to him.

It must be pointed out that it is just as imperative to avoid bringing extraterrestrial germs back to Earth. There might well exist

bacteria or viruses harmful not only to man and animals, but even to inorganic matter (they could cause certain chemical oxidation or decomposition reactions that would alter metals or alloys, etc.).

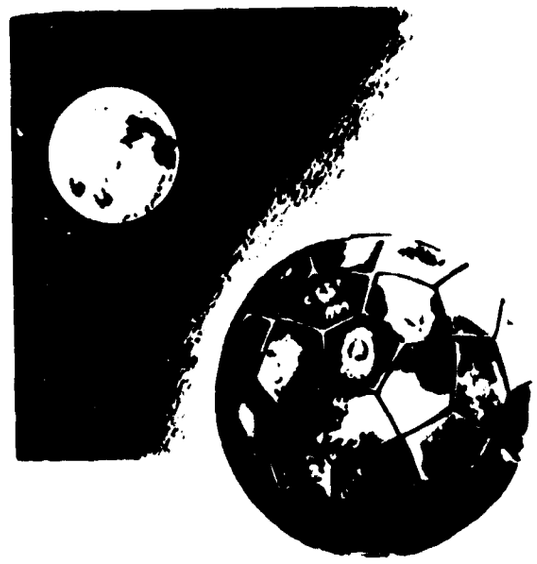
It is probable that microbiologists will also be consulted at launchings on and returns from cosmic trips, and that a real quarantine, like that to which foreign vessels are now subjected when entering a new port, will be imposed.

BIOASTRONAUTICAL RESEARCH IN OUR COUNTRY

In addition to the medical problems posed by the passengers of spaceships, there are some connected with the workers on Earth who take part in the tracking of the space flights. Among these are the radar observers. This is a problem that has preoccupied, in our country, Dr. M. Carapancea, Dr. M. Popescu, and Dr. M. Stefan, who have presented to the recent Varna Astronautics Congress a paper on this theme. As we know, the radar observers sit in a dark room and follow luminous signals that appear on a screen similar to that of a television set.

After a certain period of time, these radar observers begin to suffer from visual disturbances, namely their perception of the images on the screen is sometimes confused, sometimes clear. In medical terms, it is said that they suffer from accommodative asthenopia due to purely functional causes. The muscles that govern the power of accommodation - the function of the eyeball of forming a clear image on the retina of objects situated at various distances from the eye - become strained, and thus the disturbances mentioned make their appearance.

Thus, the authors regard these disturbances as a state of visual neurosis making its appearance as a consequence of the nervous hypertension undergone by the radar observers at work. On the other hand,



findings regarding certain other disturbances are explained by the absence of normal luminous excitation.

In concluding their communication, the authors demonstrate that all these visual and general disturbances can be prevented by a series of measures, such as: careful checking of the visual acuity of the radar observers and the selection only of suitable persons for this work, the administering of foods rich in vitamins A, B, B_1 and C, the avoidance of lengthy periods in darkness during the day, exposure of the organism to light baths, etc.

Another paper on bioastronautics was presented to the recent International Astronautics Congress by the Rumanian researchers Dr. Gr. Arsenescu, Dr. S. Schiau, and Dr. Al. Ionescu, on the problem of how the cardiovascular system adapts itself to various sea-level and hypobaric conditions with or without a compensating suit.

We know that during flight the astronauts wear a special suit, which is needed primarily for takeoff and landing, in case of trouble (should the hermetically closed capsule lose its airtightness), or in the event they leave the vehicle with its artificial atmosphere.

The function of supporting the internal organs during the overstresses that occur on placing in orbit and when returning to Earth is similar to that of the compensating suits which are used by the pilots of high-speed and high-altitude airplanes. Such suits, as well as oxygen breathing, help pilots – and astronauts – to endure these particular flight conditions.

The authors of the paper have studied how the pilots adapt them-

1 PERIOADA ZBORULUI		2 FRECVENTA		3 FRECVENTA	
		5 PULSULUI	6 RESPIRATIE	8 PULSULUI	9 RESPIRATIEI
10 Înainte de zbor	cu 4 ore 10a	70 75	10 12	78 82	14 16
	cu 5 min 10b	115	2	110	28
11 Perioada activă		105 120	10	105 130	10
La începutul zborului orbital		12 100	10	90	16
După 10 ore	13	80	14	60 62	14
„ 25 ore	14	65	16 18	60	12
„ 50 ore	15	60	10	72	15

Pavel Popovich in his space suit; the table shows the changes in pulse and breathing frequency of the two Soviet astronauts before the flight and during the flight. 1) Period of flight; 2) A. Nikolaev; 3) P. Popovich; 4) frequency; 5) pulse; 6) breathing; 7) frequency; 8) pulse; 9) breathing; 10) before flight; 10a) 4 hours before; 10b) 5 minutes before; 11) active period; 12) at start of orbital flight; 13) after 10 hours; 14) after 25 hours; 15) after 50 hours.

selves with such aids to pressure conditions similar to the ones at altitudes of 5000, 12,000, 16,000 and 18,000 m. By recording continuously the pulse and breathing rates and blood pressure, by taking electrocardiograms and monitoring the dynamic activity of the heart by radiological methods, researchers have reached some interesting conclusions.

Thus, under normal pressure conditions, use of the compensating suit and oxygen permitted modifying to a certain extent the activity of the heart and the respiratory system. No doubt, this involves conditioned reflexes: the pilot's organism, sensing the preparations that had always preceded a high altitude flight, i.e., a flight at low pressure, prepared itself for such conditions.

Pilots, when placed in a barochamber, wnether or not equipped with a compensating suit, but having been administered oxygen, adapted themselves well to conditions of low pressure by acceleration of the pulse rate and lowering the resistance encountered by the blood in traveling from the heart to the periphery of the body.

The flight of a spaceship is followed on the screen of a ground station.

It was possible to draw the conclusion that the main factor in this adaptation was not the compensating suit, but the oxygen administered.

We have presented above a few aspects of the problems discussed within the framework of the Section on Bioastronautics at the 13th Congress of the International Astronautics Federation.

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[Footnote]

3 The vestibular apparatus, situated in the internal ear, has some small bones – called otoliths – whose position conditions equilibrium and orientation.